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About the spatial distribution of the algae and the quantitative development of periphyton in the Hungarian part of Lake Fertö (Neusiedler See)

K. Buczkó

Botanical Department of the Hungarian Natural History Museum, H-1476 Budapest, Pf. 222.

Abstract: The periphyton was examined in 4 inner lakes of brownish coloured water in the Hungarian part of Lake Fertö at the autumn aspect. 169 taxa were found (Cyanophyta 13, Bacillariophyceae 130, Euglenophyta 3, Chlorophyta 13). In all the 4 lakes diatoms predominated in numbers and biomass. This phenomenon does not agree with the usual seasonal succession. Periphyton is most similar in floristics, quantity and species variability in the case of Lake Kisherlakni and Lake Atjaro. Lake Hidegsegi differs most from the other three lakes.

Kurzfassung: Der Herbstaspekt des Periphytons von 4 Schilflacken des ungarischen Teiles des Fertö wurde untersucht. 169 Taxa wurden gefunden (Cyanophyta 13, Bacillariophyceae 130, Euglenophyta 3, Chlorophyta 13). In Anzahl und Biomasse herrschten die Diatomeen vor, was nicht mit der üblich gefundenen Sukzession übereinstimmt. Artenspektrum, Quantität und Artenvariabilität des Periphytons sind im See Kisherlakni und Atjaro am ähnlichsten; das Periphyton aus dem See Hidegsegi unterscheidet sich von jenem der anderen am stärksten.

Introduction

The cover forming algae of seaside banks have been examined for a long time both from the taxonomical and ecological point of view (Heijs, 1984; Maples, 1984; Szlávec, 1985). Freshwater periphyton have come to the front only nowadays, however, the epiphytic algae are more significant here even when considering the relative proportion of shoreline environment only. For the time being researchers carried out mainly descriptive works (space pattern, host specifity, seasonal succession), and hence there is an increasing demand on more knowledge about the role of the periphyton in lakes and rivers (Wetzel, 1983). In the case of Fertö, the periphyton is interersting and important especially because of the extended reed-belt, enclosing the grey-coloured open water. Inside this reed-belt, some pools containing brownish water can be found; these are undisturbed by wind. These pools have small surface, high Secchi transparency (and often they are illuminated down to the bottom).

The algological examination of the reeds of Fertö was started by Loub (1955), followed after a longer break by Padisák (1982). Besides valuable floristical data, this paper reports on a rough spatial pattern of periphyton. On the basis of floristical data, Padisák pointed out that in Lake Fertö the quality of water is more determinant for epiphytic algae than the kind of substratum. In this work a quantitative estimation on the biomass of periphyton im terms of Chlorophyll-a content is given also.

The quantitative examination of periphyton was started in 1982, with an analysis of the algal coat of 50 reeds (Buczkó & Padisák, 1980). The substrate specificity of one small inner lake was studied on the basis of quantitative data. Floristical differences were found between the coat of *Schoenoplectus* and

Phragmites; periphyton of *Typha* has a greater diversity than that of the two substrates before (Buczkó, 1986).

The purpose of the present study is to observe whether the different pools have different periphytic algal flora (in the case of same substrate) and to compare the quantity of periphyton with the quantity of plankton, and to increase the phycological knowledge of Lake Fertö.

Materials and methods

Our samples of periphyton were collected on 9th November 1983 fom 4 brownish pools of the reed-belt of the Hungarian part of Lake Fertö (Fig. 1). Among these four pools, lake Herlakni has the largest open water surface (540 000 m^2), i.e. 0,72 % of the lake Fertö area. The second largest is lake Hidegsegi (0,16%). The third is lake Atjaro (0,036 %), and the smallest (0,030 %) is lake Kisherlakni (Bacsatyai-Markus, 1983).

Every sampling location was sampled 15 times in the following way: the upper parts of the reed stems were cut off, then a glass tube (13 mm diameter, 0,2 m in length), was pulled over the underwater stump and cutt off at the end of tube. The lower end of the tube was closed and the section of the stem thus transferred into a collecting jar. These jars were carried to the laboratory within 6 hours, where the samples were fixed in formaldehyde solution. The algal mass was washed or scratched off by knife and then homogenized. Without exact identification, the number of individuals was counted and the ratio of diatoms and other algae determined. For the identification of diatoms permanent diatom slides were prepared with the H_2O_2 method (Horvath, 1975) and embedded in Styrax. These slides are available in the diatom collection of the Department of Botany of the Hungarian Natural Museum. Four hundred individuals were counted in each sample, that is altogether 6 000 individuals for one pool. For identification the follwing references were used: Pantocsek, 1912; Hustedt, 1930, 1959a, 1959b, 1959c; Felföldy, 1972; Bartha et al, 1976; Németh, 1980.

The biomass on a reed stem was calculated in the known and accepted way of plankton examinations (immediate measurements, approach by geometrical figures); it was calculated using individual numbers. The surface and dry mass of reed stems was measured (after 2 hours drying on 105 °C). Based on these data, the number of individuals and the biomass with respect to mass or surface of the reed stem can be computed immediatly. For comparing the mean values the t-test was used.

The Shannon diversity index (Shannon, 1948) was calculated for each sample. Data were analyzed using cluster analysis based on Hummons measure (Hummon, 1974), and WPGMA fusion algorithm (Sneath & Sokal, 1973). For the calculations the BP programme package was used (Rajczy & Hajdu, 1981).

Results

169 taxa were identified: Cyanophyta - 13, Xanthophyta-Bacillariophyceae - 130, Euglenophyta - 3, Chlorophyta - 13 (see Table 1). The ratio of taxa found according to phyla can be seen on Fig. 2. The

great quantity of diatoms are characteristic of the periphyton of all the four lakes (minimum 80 % - Lake Atjaro; maximum 92 % - Lake Herlakni). Considering the number of individuals, the diatom dominance is even more pronounced, the contribution of other algal groups to the total number of individuals are negligible:

	Lake Herlakni	Lake Kisherlakni	Lake Atjaro	Lake Hidegsegi
Cyanophyta	6	22	96	18
Bacillariophyceae	5982	5957	5859	5981
Euglenophyta	-	1	2	-
Chlorophyta	6	20	63	1

Among the diatoms the Pennales are most characteristic. Only 4 species (11 individuals, 0,05 %) belong to the Centrales. The periphyton biomass forming species of these four pools of Lake Fertö are listed below; only those species are listed, of which more than 1 % (240 individuals) were found (percentage of all the algae counted) the list is made according to the summarized species list of the fifteen reed covers of all the four pools:

	Lake Herlakni	Lake Kisherlakni	Lake Atjaro	Lake Hidegsegi
Achnanthes minutissima	10,18	6,79	4,71	17,72
Amphora perpusilla	-	0,02	2,09	-
Cocconeis pediculus	0,87	0,20	0,35	0,38
Cymbella affinis	2,28	0,08	0,11	0,03
Cymbella lacustris	1,35	-	-	0,05
Cymbella sp.	0,33	0,57	1,31	0,27
Diatoma elongatum	0,78	7,35	4,82	3,75
Gomphonema sp.	0,70	1,69	0,58	0,43
Navicula cryptocephala var veneta	0,54	0,73	0,64	0,28
Nitzschia amphibia	0,08	0,80	1,58	0,07
Rhoicosphenia curvata	1,92	0,51	0,96	0,08
Synedra acus	0,43	0,44	0,50	0,25
Synedra ulna	0,70	1,55	1,35	0,17
Synedra vaucheriae	1,48	-	0,01	0,01

It is remarkable, that there are only 3 species that do not occur in all the four pools; on the other hand, there is a significant difference in the occurrence of mass species, and there is a significant difference in the frequency of the species. *Achnanthes minutissima* is dominant in Lake Herlakni and Lake Hidegsegi and only subdominant in the Lake Kisherlakni and Lake Atjaro. In these two latter pools *Diatoma* *elongatum* is the dominant which is the second in Lake Hidegségi, and only seventh in Lake Herlakni (see Fig. 3). *Amphora perpusilla* is the third in frequency in Lake Atjaro, and is lacking in the two other pools; *Cymbella lacustris* is the fifth in frequency in Lake Herlakni, and is not found in Lake Kisherlakni and Lake Atjaro.

The numbers of species in the pools studied are the following: the poorest in species is Lake Hidegsegi with 54 species; there were 85 species in Lake Herlakni and 103 species both in Lake Kisherlakni and Lake Atjaro. (See Table 1 for the details of occurrence.)

Results of cluster analysis show that the periphyton of the four pools studied is different (fig. 4), that is the 4 x 15 samples are strictly separated from each other. Samples of Lake Kisherlakni and Lake Atjaro are the most similar. Note that these two pools have the largest number of individuals. Among the 4 sample-series, the one originating from Lake Hidegsegi is the most separated from others on the dendrogram. This separation is indicated by its low diversity too (Fig. 5).

Quantitative features of periphyton

The quantity of periphyton is shown in Table 2. To relate to surface unit has a sensible biological meaning but its measurement is less exact, while measuring the mass can be very exact but its interpretation is questionable. In general, quantities are given in relation to surface unit, but we have some data relating to dry mass just from Lake Fertö (Sommer, 1977). The individual numbers are the same at a = 10 % level of significancy in Lake Kisherlakni and Lake Atjaro. All the other pairs of pools show significant differences.

Discussion

On the basis of the above results, the four pools studied are significantly different. This fact confirms the hypothesis that though these pools are close to each other in distance, they have their own life. Plankton examinations in these pools (Padisák, 1983) gave similar results. The results show the role of reed as a filter, i.e. it can separate waters of different water quality. Periphyton is most similar in case of Lake Kisherlakni and Lake Atjaro. These two pools are the smallest of the 4 pools studied, their periphyton is similar in the floristic aspect and the quantitative and species variability.

It is difficult to explain the predominance of diatoms. Most of the papers concerning seasonal succession of periphyton report a diatom peak in spring both on artificial (Hooper-Reid &Robinson, 1978) and natural (Jones & Mayer, 1983) substrates. According to these references the quantity of diatoms is decreasing continuously in summer and autumn, while the quantity of blue-green algae is increasing.

Appearance of heterocystic blue-green algae, which can be expected in late summer or early autumn (like in case of planktonic-algae) correlate with nitrogen limitation (Hooper-Reid & Robinson, 1978). Nitrogen-fixing blue-green algae can be totally absent in plankton, while in periphyton they can be as numerous as they can fix 50 % of the whole amount of nitrogen fixed by algae. Heterocystic blue-green algae are missing from periphyton in every season of the year (Padisák, 1982; Khondker & Dokulil, 1986). To solve this question a detailed examination of seasonal succession is needed.

Results of both, quantitative and qualitative examinations show good similarity with the results of artificial (Goldsborough & Robinson, 1985) and natural (Duthie & Hamilton, 1983) substrate examinations. About 10^3 algal cells/m^2 of surface of substrate are found while, in plankton, the number of individuals per litre is about 10^5 - 10^6 (Padisák, 1983). That means about 1 000 - 10 000 times more algae live in the reed belt on one square metre surface of reed stems immediatley under the water surface, than in one litre of open water. In terms of biomass, the difference may be even more pronounced, since in periphyton the size of algae can be larger (e.g. *Spirogyra*). Unfortunateley, we do not have a basis for comparison for this in the case of the inner lakes of Fertö.It is worth to note that a reed-stem, close to the water surface can carry as much as 10 % of its mass as algal cover.

References

Bacsatyai, I. & I. Markus, 1983: A Fertö-to Bioszfera Rezervatum vizsgalata a fotoertelmezes modszerevel. I. A. Fertö-to nadasainak vizsgakata, nadvegetacios terkep keszitese. Kutatasi jelentes Sopron. (Investigation of the Lake Fertö Biosphere Reseve by means of Interpretation aeral-photograph. I. Production of a vegetation map of the reeds of Lake Fertö) Manuscript.

Bartha, Z., L. Felföldy, L. Hajdu, K. Horvath, K. Kiss, A. Schmidt, G. Tamas, G. Uherkovich & I. Vörös, 1976: Chlorococcales. In Felföldy, L. (ed.): Hydrobiol. for Water Management Praxis Vol. 4. Budapest.

Buczko, K., 1986: A comparative study of the periphytic algae on three different flower plant species in Lake Hidegsegi Fertö, Hungary. - Stud. Bot. Hung. 19: 63-71.

Buczko, K. & J. Padisák, 1988: A Fertö Atjaro tavanak perifitikus kovaalgai. (The periphytic diatoms of Lake Atjaro Fertö). - Bot. Közlem. (in press).

Duthie, H.C. & P.B. Hamilton, 1983: Studies on periphyton community dynamics of acidic streams using track autoradiography. In: Wetzel, R.G. (Ed.): Periphyton of Freshwater Ecosystems. W.Junk Publishers, The Hague, pp: 185-189.

Felföldy, L., 1972: A kekalgak (Cyanophyta) kishatarozuja. In Felföldy, L. (Ed.): Hydrobiol. for Water Management Praxis Vol. 10. Budapest.

Goldsborough, L.G. & G.G.C. Robinson, 1985: Seasonal succession of diatom epiphyton on dense mats of Lemna minor. Can. J. Bot. 63: 2332-2339.

Heijs, F.M.L., 1984: Annual biomass and production of epiphytes in three monospecific seagrass communities of Thalassia hemprichii (Ehrenbr.) Aschers. Auqatic Botany 20: 195-218.

Hooper-Reid, N.M. & G.G.C. Robinson, 1978: Seasonal dynamics of epiphytic algal growth in a marsch pond: productivity, standing crop and community composition. Can. J. Bot. 56: 2434-2440.

Horvath, K., 1975: A novel rapid method for preparation of diatoms. Acta Biol. Debrecina 12: 117-118.

Hummon, W.D., 1974: Similarity index based on shared species diversity, used to assess temporal and spatial relations among intertidal marine gastrotricha. Oecologia 17: 203-220.

Hustedt, F.; 1930: Bacillrariophyta (Diatomeae). In: Pascher, A. (Ed.): Die Süßwasser-Flora Mitteleuropas. Fischer Verlag, Jena, Heft 10.

Hustedt, F., 1959a: Die Diatomeenflora des Neusiedler Sees im österreichischen Burgenland. - Öst. Bot. Z. 106: 390-430.

Hustedt, F., 1959b: Bemerkungen über die Diatomeenflora des Neusiedler Sees und Salzlackengebietes. In: Landschaft Neusiedler See. Wiss. Arb. Bgld. 23: 129-133.

Hustedt, F.; 1959c: Die Diatomeenflora des Salzlackengebietes im österreichischen Burgenland. - Sitz. Ber. österr. Akad. Wiss:, Math., nat. Kl. I 168: 387-452.

Jones, R.D. & K.B. Mayer, 1983: Seasonal changes in the taxonomic composition of epiphytic algal communities in Lake Wingra, Wisconsis in USA. In Wetzel, R.G. (Ed.): Periphyton of Freshwater Ecosystems. W. Junk Publishers The Hague pp: 11-16.

Loub, W., 1955: Algenbiozönosen des Neusiedler Sees. - Sitz. Ber. österr. Akad. Wiss., Math. - nat. Kl. I. 164: 81-107.

Khondker, M. & M. Dokulil, 1986: Beiträge zur Kenntnis der epipelischen Algenflora des Neusiedler Sees mid besonderer Berücksichtigung ihrer Populationsdynamik, Biomasse und Produktion. BFB-Bericht 58: 5-20.
Maples, S.R., 1984: The epiphytic diatom flora of two Sargassum species. Gulf Research Reports 7: 373-375.
Németh, J. 1980: Az ostoros algak (Euglenophyta) kishatarozoja. In Felföldy, L. (Ed.): Hydrobiol. for Water Management Praxis Vol. 4 Budapest.
Padisák, J., 1982: The periphyton of Lake Fertö species composition and Chlorophyll-a-content. BFB-Bericht 43: 95-115.
Padisák, J.; 1983: A comparison between the phytoplankton of some brown water lakes enclosed with reed-belt in the Hungarian part of Lake Fertö. BFB-Bericht 47: 133-155.
Pantocsek, J., 1912: A Fertö to kovamoszat viranya (Bacillariae lacus peisonis) Pozsony.
Rajczy, M. & L. Hajdu, 1981: BP - a package of Fortran programmes for biologists. - Manuscript.
Shannon, C.E., 1948: A mathematical theory of communication. Bul. System. Techn. J. 27: 379-423, 623-656.
Sneath, P.H.A. & R.R. Sokal, 1973: Numerical Taxonomy. Freeman, San Francisco.
Sommer, U., 1977: Produktionsanalysen am Periphyton im Schilfgürtel des Neusiedler Sees. Sitz. Ber. österr. Akad. Wiss., Math. - nat. Kl. Abt. I. 186: 219-246.
Szlavec, K., 1985: Sziklas tengerparti tarsulasok szervezödese es szukcesszioja. (Oorganisation and succession of communities on marine rocky shores. In: Fekete, G. (Ed.): A cönologiai szukcesszio kerdesei. - Akademiai Kiado Budapest pp: 189-201.
Wetzel, R.G., 1983: Periphyton of Freshwater Ecosystems. W. Junk Publishers The Hague pp: 1-346.

Table 1: List of periphytic algae found in the four studied lakes. (I = Lake Herlakni, II = Lake Kisherlakni, III = Lake Atjaro, IV = Lake Hidegsegi, a: number of individual, min: 1, max: 6000, b: number of occurences, min: 1, max: 15)

	I		II		III		IV	
	a.	b.	a.	b.	a.	b.	a.	b.
CYANOPHYTA								
1. Chroococcus minutus (Kg.) Näg.	-	-	-	-	-	-	1	1
2. Chroococcus turgidus (Kg.) Näg.	-	-	1	1	5	2	-	-
3. Gomphosphaeria lacustris Chodat	-	-	1	1	-	-	-	-
4. Lyngbya martensiana Menegh.	-	-	9	5	3	2	-	-
5. Lyngbya sp.	2	2	4	3	13	3	-	-
6. Microcystis sp.	-	-	-	-	3	2	8	3
7. Oscillatoria amphibia Agh.	-	-	-	-	-	-	1	1
8. Oscillatoria limnetica Lemm.	-	-	-	-	1	1	-	-
9. Oscillatoria sp. 1	2	1	-	-	45	11	0	3
10. Oscillatoria sp. 2	-	-	-	-	21	3	-	-
11. Pseudanabaena catenata Lauterb.	-	-	-	-	3	2	-	-
12. Spirulina maior Kg.	2	2	-	-	-	-	-	-
13. Spirulina subsalsa Oerst.	-	-	7	5	-	-	-	-
XANTHOPHYTA - BACILLARIOPHYCEAE								
14. Achnanthes exigua Grun.	-	-	2	1	-	-	-	-
15. Achnanthes grimmei Krasske	-	-	6	6	-	-	-	-
16. Achnanthes minutissima Kütz.	2442	15	1629	15	1131	15	4253	15
17. Amphiprora alata Kütz.	41	13	12	8	29	12	-	-
18. Amphiprora costata Hust.	-	-	-	-	-	-	2	1
19. Amphiprora paludosa W.Smith	-	-	1	1	-	-	-	-
20. Amphora coffeaeformis Agardh.	-	-	5	5	-	-	-	-
21. Amphora commutata Grun.	8	5	4	4	1	1	-	-
22. Amphora delicatissima Krasske	-	-	1	1	-	-	-	-
23. Amphora ovalis Kütz.	1	1	1	1	78	15	-	-
24. Amphora ovalis var. pediculus Kütz.	6	5	6	3	29	7	6	5
25. Amphora perpusilla Grun.	-	-	5	4	501	15	-	-
26. Amphora veneta (Kütz.)	-	-	2	2	19	10	-	-
27. Anomoeoneis sphaerophora (Kütz.) Pfitzner	6	5	1	1	1	1	-	-
28. Anomoeoneis sphaerophora var. polygramma (Ehr.) O.Müll.	2	1	1	1	2	2	-	-

Table 1 continued

	I a.	I b.	II. a.	II. b.	III. a.	III. b.	IV. a.	IV. b.
29. Bacillaria paradoxa Gmelin	71	72	72	12	12	6	76	14
30. Campylodiscus clypeus Ehr.	73	14	5	4	4	4	2	2
31. Cocconeis nuda Pant.	2	2	-	-	-	-	-	-
32. Cocconeis pediculus Ehr.	208	15	48	11	83	14	90	13
33. Cocconeis placentula (Ehr.)	24	11	5	3	42	11	-	-
34. Cocconeis placentula var.euglypta (Ehr.) Cleve	-	-	-	-	-	-	2	1
35. Cocconeis thumensis A.Mayer	-	-	-	-	-	-	1	1
36. Cyclotella catenata Brun.	1	1	2	2	2	2	-	-
37. Cyclotella glomerata Bachmann	-	-	1	1	-	-	-	-
38. Cyclotella kützingiana Thwaites	-	-	2	1	-	-	-	-
39. Cyclotella meneghiana Kütz.	-	-	-	-	3	3	1	1
40. Cymbella affinis Kütz.	547	15	18	10	27	13	8	4
41. Cymbella amphicephala Naegeli	1	1	7	6	-	-	-	-
42. Cymbella aspera (Ehr.) Cleve	1	1	9	5	17	7	-	-
43. Cymbella brehmii Hust.	-	-	2	2	61	12	-	-
44. Cymbella cistula (Hemprich) Grun.	32	9	6	5	38	12	1	1
45. Cymbella cistula var.maculata (Kütz.)v.Heurck	4	4	14	9	8	5	-	-
46. Cymbella hustedtii Krasske	1	1	14	7	8	2	-	-
47. Cymbella lacustris (Agardh.)Cleve	324	15	-	-	-	-	13	4
48. Cymbella lanceolata (Ehr.)v.Heurck	-	-	-	-	15	6	-	-
49. Cymbella microcephala Grun.	2	2	11	7	-	-	9	4
50. Cymbella prostrata (Berkeley) Cleve	-	-	2	2	6	4	5	3
51. Cymbella pusilla Grun.	-	-	-	-	-	-	13	10
52. Cymbella tumidula Grun.	-	-	-	-	-	-	1	1
53. Cymbella turgida (Gregory) Cleve	2	1	-	-	1	1	-	-
54. Cymbella ventricosa Kütz.	5	3	101	15	185	15	39	13
55. Cymbella sp.	80	14	137	15	305	15	64	13
56. Diatoma elongatum Agardh	186	15	1763	15	1156	15	900	15
57. Diatoma vulgaris var.ovalis (Fricke) Hust.	-	-	-	-	1	1	-	-
58. Diploneis ovalis (Hilse) Cleve	1	1	-	-	-	-	-	-
59. Epithemia argus Kütz.	1	1	-	-	-	-	-	-
60. Epithemia sorex Kütz.	3	2	-	-	-	-	-	-
61. Epithemia turgida (Ehr.) Kütz.	-	-	-	-	17	7	-	-
62. Epithemia zebra (Ehr.) Kütz.	2	2	-	-	2	2	-	-
63. Epithemia zebra var.saxonica (Kütz.) Grun.	3	2	-	-	-	-	-	-
64. Epithemia sp.	4	2	1	1	44	13	-	-
65. Eunotia gracilis (Ehr.) Rabenhorst	-	-	3	3	5	3	-	-
66. Eunotia lunaris (Ehr.) Grun.	-	-	7	4	-	-	-	-
67. Eunotia lunaris var.subarcuata (Naeg.)Grun.	-	-	1	1	-	-	-	-
68. Fragilaria bicapitata A.Mayer	12	1	-	-	22	3	-	-
69. Fragilaria brevistriata var.inflata (Pantocsek) Hust.	7	5	-	-	-	-	-	-

Table 1 continued

	I.		II.		III.		IV.	
	a.	b.	a.	b.	a.	b.	a.	b.
70. Fragilaria construens (Ehr.)Grun.	10	8	-	-	1	1	-	-
71. Fragilaria construens var.binodis (Ehr.)Grun.	-	-	2	2	-	-	1	1
72. Fragilaria construens var.subsalina Hust.	-	-	2	1	-	-	-	-
73. Fragilaria intermedia Grun.	-	-	-	-	1	1	-	-
74. Fragilaria pinnata Ehr.	4	3	-	-	7	2	-	-
75. Fragilaria pinnata var.lanzettula Hust.	4	1	-	-	-	-	-	-
76. Fragilaria virescens Ralfs	-	-	-	-	13	5	-	-
77. Fragilaria sp.	-	-	3	1	16	2	-	-
78. Gomphocymbella sp.	-	-	-	-	18	1	-	-
79. Gomphonema acuminatum var. brebissonii (Kütz.) Cleve	-	-	6	4	1	1	1	1
80. Gomphonema augur Ehr.	-	-		-	1	1	-	-
81. Gomphonema apiculatum Ehr.	-	-	14	7	-	-	-	-
82. Gomphonema intricatum Kütz.	1	1	4	3	-	-	-	-
83. Gomphonema intricatum var.pumila Grun.	-	-	2	2	-	-	-	-
84. Gomphonema lanceolatum Ehr.	-	-	5	5	2	2	-	-
85. Gomphonema longiceps Ehr.	-	-	1	1	3	1	-	-
86. Gomphonema longiceps var.subclavata Grun.	-	-	1	1	-	-	2	1
87. Gomphonema longiceps var.subclavata f.gracilis Hust.	-	-	3	2	-	-	4	3
88. Gomphonema olivaceum (Lyngbye) Kütz.	13	7	63	13	17	6	-	-
89. Gomphonema olivaceum var.calcarea Cleve	12	2	88	14	42	10	1	1
90. Gomphonema parvulum Kütz.	-	-	-	-	9	6	-	-
91. Gomphonema parvulum var.micropus (Kütz.)Cleve	-	-	2	1	-	-	-	-
92. Gomphonema sp.	168	15	406	15	140	15	103	13
93. Gyrosigma spencerii (W.Smith) Cleve	1	1	-	-	-	-	-	-
94. Gyrosigma sp.	-	-	-	-	-	-	1	1
95. Mastoglia smithii var.amphiocephala Grun.	7	5	4	4	1	1	-	-
96. Navicula cari Ehr.	40	9	-	-	-	-	-	-
97. Navicula cryptocephala Kütz.	12	9	9	8	15	9	3	2
98. Navicula cryptocephala var. intermedia Grun.	24	8	27	7	16	7	-	-
99. Navicula cryptocephala var.veneta (Kütz.) Grun	129	15	174	14	153	15	68	13
100. Navicula cuspidata Kütz.	1	1	1	1	-	-	1	1
101. Navicula cuspidata var.ambigua (Ehr.)Cleve	1	1	-	-	1	1	1	1
102. Navicula gothlandica Grun.	-	-	1	1	-	-	-	-
103. Navicula gregaria Donkin	-	-	-	-	-	-	1	1
104. Navicula halophila (Grun.) Cleve	4	3	28	10	14	7	-	-
105. Navicula halophila f.robusta Hust.	3	3	1	1	1	1	-	-
106. Navicula hungarica Grun.	3	2	2	1	1	1	-	-
107. Navicula oblonga Kütz.	13	9	7	5	36	14	2	2
108. Navicula protracta Grun.	3	3	-	-	-	-	-	-
109. Navicula pupula var. capitata Hust.	-	-	1	1	5	3	-	-
110. Navicula radiosa Kütz.	15	9	55	15	41	14	10	6
111. Navicula saliharum f.capitata Schulz.	4	4	-	-	1	1	-	-
112. Navicula simplex Krasske	-	-	-	-	3	3	-	-
113. Navicula sp.	1	1	-	-	-	-	1	1
114. Nitzschia acicularioides Hust.	-	-	1	1	-	-	-	-
115. Nitzschia admissa Hust.	-	-	3	3	2	1	1	1
116. Nitzschia amphibia Grun.	20	7	191	15	380	15	17	8

Table 1 continued

	I.		II.		III.		IV.	
	a.	b.	a.	b.	a.	b.	a.	b.
117. Nitzschia angustata (W.Smith) Grun.	46.	11	1	1	2	2	2	1
118. Nitzschia apiculata (Gregory) Grun.	62	14	2	1	-	-	-	-
119. Nitzschia commutata Grun.	1	1	-	-	-	-	-	-
120. Nitzschia filiformis (W.Smith) Hust.	24	2	-	-	-	-	-	-
121. Nitzschia kützingiana Hilse	-	-	-	-	5	2	-	-
122. Nitzschia kützingioides Hust.	25	10	20	7	13	5	-	-
123. Nitzschia obtusa W.Smith	-	-	1	1	-	-	1	1
124. Nitzschia palea (Kütz.) W.Smith	2	2	4	2	9	4	1	1
125. Nitzschia sigmoidea (Ehr.) W.Smith	2	2	22	10	18	10	-	-
126. Nitzschia sublinearis Hust.	-	-	1	1	-	-	-	-
127. Nitzschia tryblionella Hantzsch.	3	3	-	-	-	-	-	-
128. Nitzschia tryblionella var.levidensis (Arnott) A.Mayer	-	-	1	1	-	-	-	-
129. Nitzschia sp.	-	-	1	1	3	1	7	4
130. Pinnularia appendiculata (Agardh) Cleve	-	-	1	1	-	-	-	-
131. Pinnularia divergens W.Smith	-	-	1	1	-	-	-	-
132. Rhoicosphaeria curvata (Kütz.) Grun.	461	15	122	14	130	14	118	13
133. Rhopalodia gibba (Ehr.) O.Müll.	10	8	1	1	11	6	-	-
134. Rhopalodia gibba var.ventricosa (Ehr.)Grun.	3	3	1	1	2	2	-	-
135. Stauroneis anceps Ehr.	-	-	2	2	-	-	-	-
136. Surirella ovalis Brébisson	-	-	1	1	-	-	-	-
137. Surirella ovata Kütz.	4	3	-	-	-	-	-	-
138. Surirella peisonis Pantocsek	-	-	1	1	-	-	-	-
139. Synedra acus Kütz.	104	15	106	14	120	15	60	12
140. Synedra affinis Kütz.	-	-	107	13	29	7	12	7
141. Synedra affinis var.fasciculata (Kütz.) Grun.	-	-	1	1	-	-	-	-
142. Synedra amphicephala Kütz.	8	3	18	6	22	7	2	1
143. Synedra capitata Ehr.	10	8	15	9	12	9	-	-
144. Synedra pulchella Kütz.	1	1	-	-	144	15	-	-
145. Synedra rumpens Kütz.	1	1	-	-	-	-	-	-
146. Synedra ulna (Nitzsch.) Ehr.	167	15	373	15	323	15	41	13
147. Synedra ulna var.amphirynchus (Ehr.) Grun.	-	-	-	-	-	-	2	1
148. Synedra ulna var.danica (Kütz.) Grun.	8	5	67	12	23	9	-	-
149. Synedra vaucheriae Kütz.	335	15	-	-	3	1	2	1
150. Bacillariophyceae sp.	85	14	60	13	89	15	-	-

EUGLENOPHYTA

151. Euglenophyta sp.	-	-	1	1	-	-	-	-
152. Phacus hamatus Pochm.	-	-	-	-	1	1	-	-
153. Phacus sp.	-	-	-	-	1	1	-	-

Table 1 continued

	I. a.	I. b.	II. a.	II. b.	III. a.	III. b.	IV. a.	IV. b.
CHLOROPHYTA								
154. Chlorococcales sp.	1	1	-	-	27	6	-	-
155. Chlorella sp.	-	-	2	1	-	-	-	-
156. Cosmarium sp.	-	-	-	-	1	1	-	-
157. Crucigenia sp.	-	-	-	-	1	1	-	-
158. Pediastrum boryenum (Turp.) Menegh.	1	1	-	-	-	-	-	-
159. Protococcus sp.	-	-	-	-	2	2	-	-
160. Scenedesmus ecornis (Ralfs)Chod.	-	-	-	-	1	1	-	-
161. Scenedesmus quadricauda Chod.	1	1	1	1	11	6	-	-
162. Scenedesmus spinosus Chod.	-	-	-	-	3	3	-	-
163. Scenedesmus sp.	-	-	-	-	3	3	1	1
164. Spirogyra sp.	-	-	5	3	6	5	1	1
165. Ulotrichales sp.	3	3	3	2	6	5	-	-
166. Charachium sp.	-	-	9	5	2	2	-	-

Table 2: The mean and standard deviation of number of individuals and biomass of periphyton related to surface unit and mass unit of reed. (P = periphyton, M = makrophyta)

		Lake Herlakni x	Lake Herlakni S_{n-1}	Lake Kisherlakni x	Lake Kisherlakni S_{n-1}	Lake Atjaro x	Lake Atjaro S_{n-1}	Lake Hidegsegi x	Lake Hidegsegi S_{n1}
individual of P / surface of M	10^9 ind.m^{-2}	6,24	5,33	3,18	1,16	3,40	1,79	4,87	3,81
individual of P / dry mass of M	10^6 ind.g^{-1}	25,38	26,18	7,65	2,74	14,94	10,58	19,67	19,9
biomass of P / surface of M	10^2 g.m^2	23,14	27,55	6,05	2,61	19,39	22,81	2,90	3,48
biomass of P / dry mass of M	10^{-3} g.g^{-1}	89,14	118,36	15,20	8,59	89,87	115,94	29,65	72,9

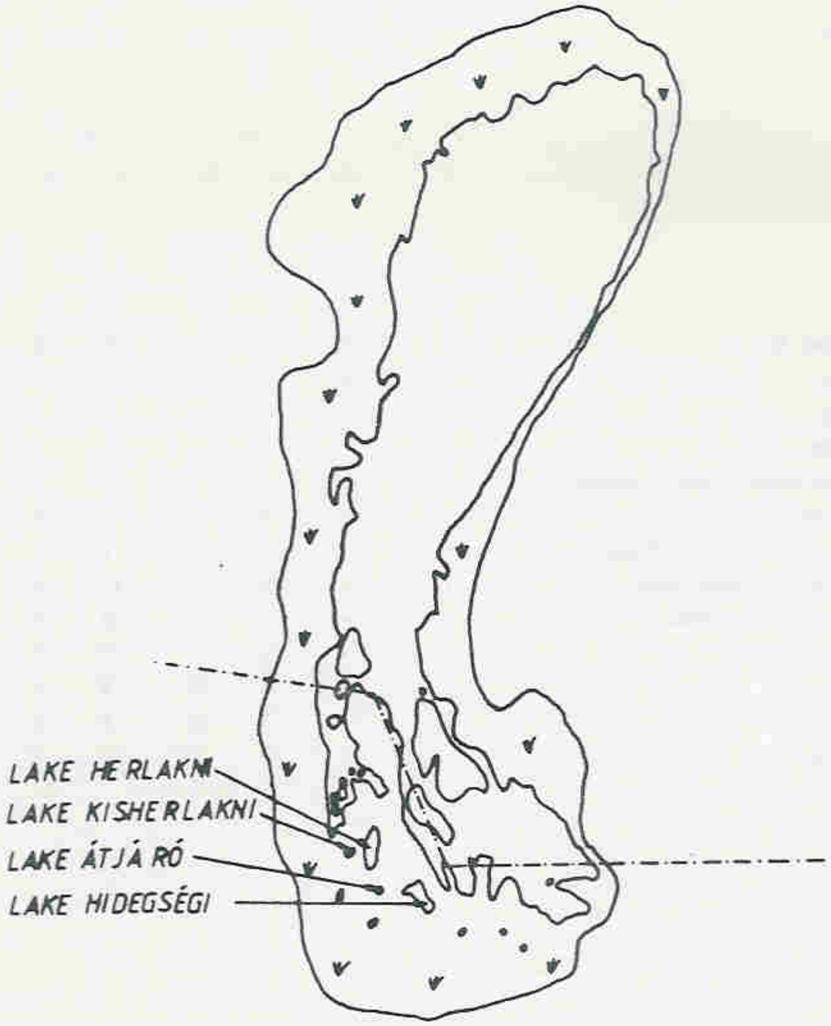

Fig. 1: Sampling locations

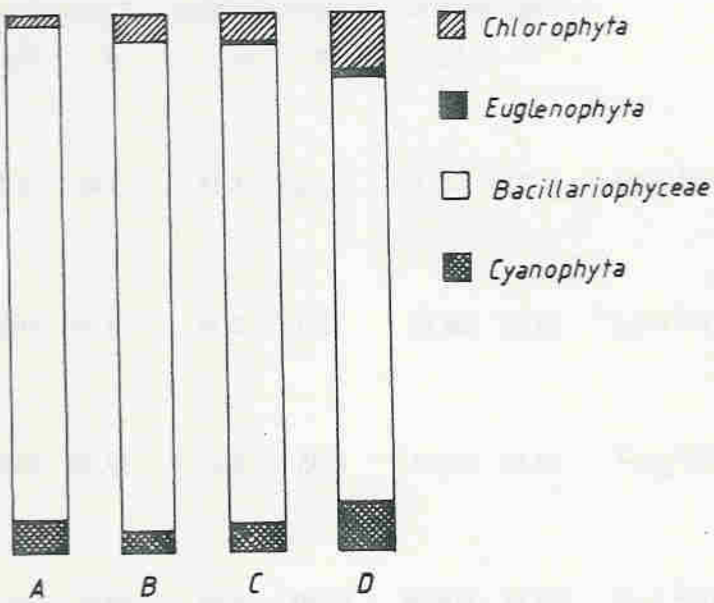

Fig. 2: The ratio of number of taxa found according to phyla.(A = Lake Herlakni, B = Lake Kisherlakni, C = Lake Atjáró, D = Lake Hidegségi).

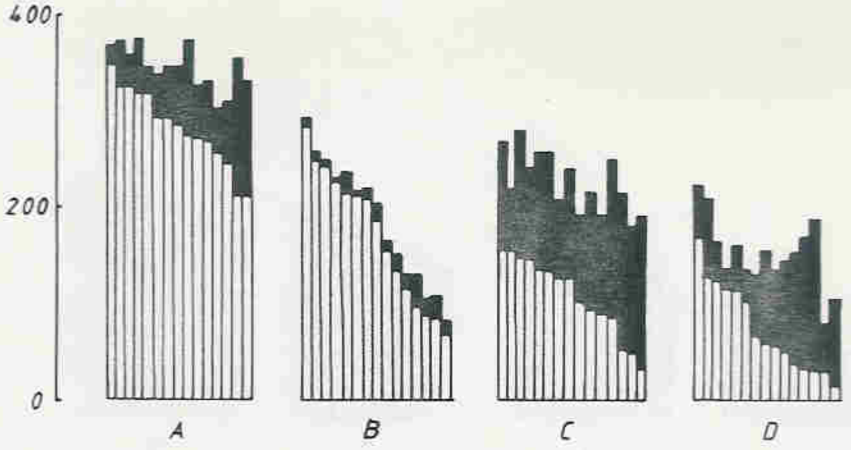

Fig. 3: The ratio of the two most frequent species in the 4 studied lakes. (White column = the number of Achnanthes minutissima, black column = number of Diatoma elongatum, A = Lake Hidegségi, B = Lake Herlakni, C = Lake Kisherlakni, D = Lake Atjáro),

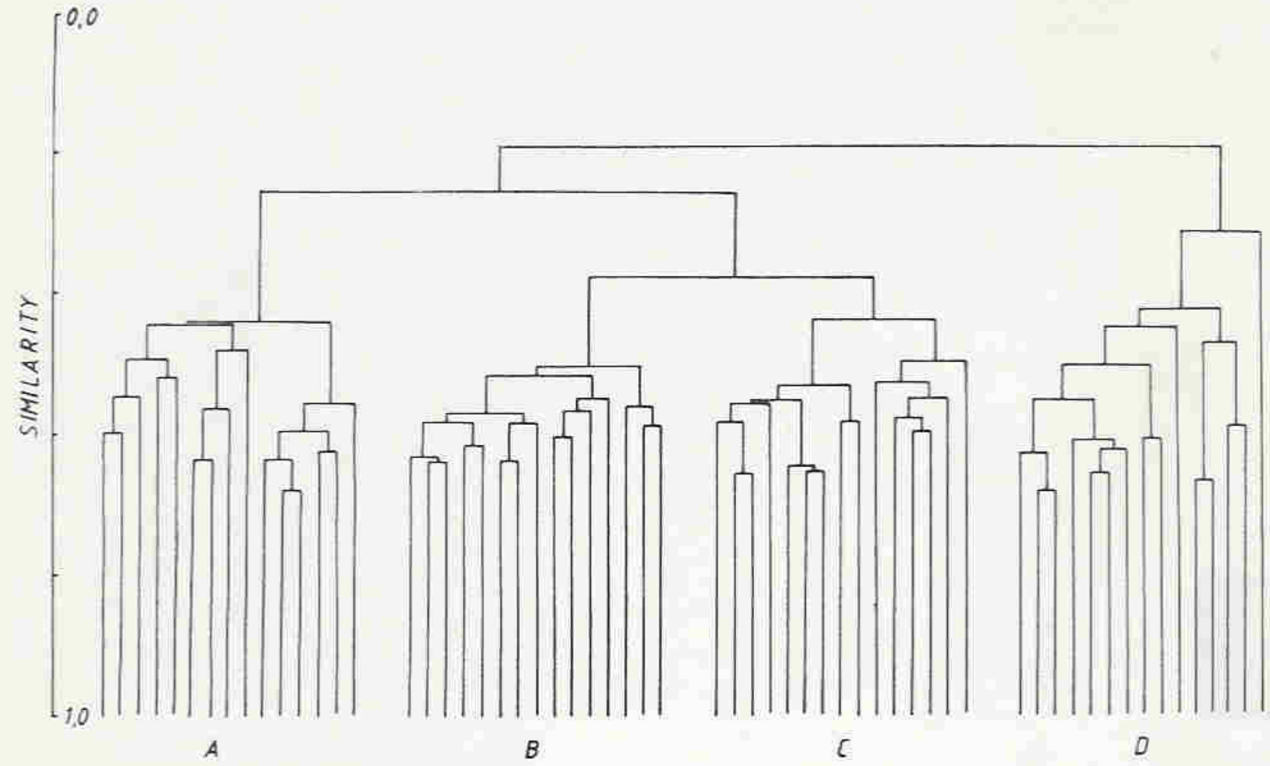

Fig. 4: Dendrogram of the priphytic samples using Hummon's similarity index. (A = Lake Herlakni, B = Lake Kisherlakni, C = Lake Atjáró, D = Lake Hidegségi).

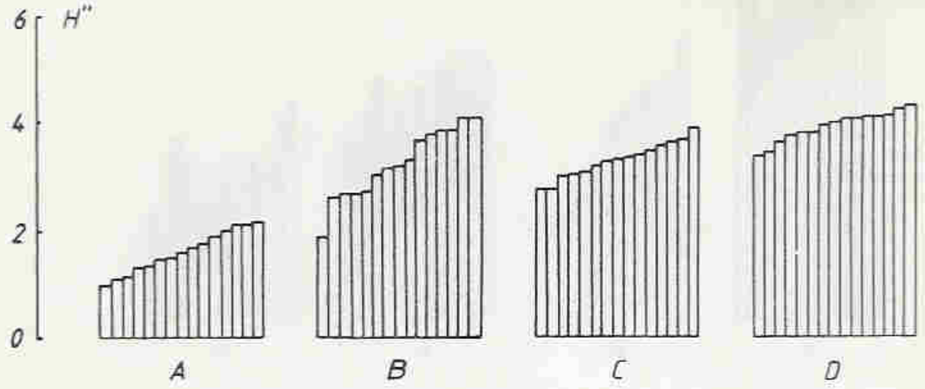

Fig. 5: Diversity distribution of the periphytons. (A = Lake Herlakni, B = Lake Kisherlakni, C = Lake Atjáró, D = Lake Hidegségi).